Smooth pursuit of flicker-defined motion

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BACKGROUND

Delayed Visual Feedback

Effect of Changing Feedback Delay on Spontaneous Oscillations in Smooth Pursuit Eye Movements of Monkeys

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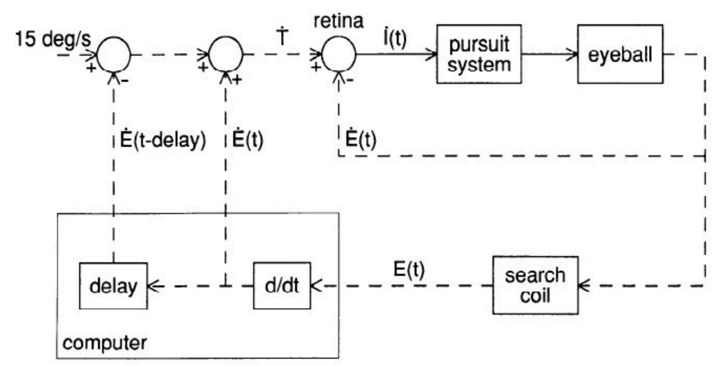


Figure from Goldreich, Krauzlis & Lisberger (1992).

Theory

$e(t)$	eye position (EP)
$p(t)$	target position
$\dot{e}(t)$	eye velocity (EV)
$\dot{p}(t)$	target velocity
$\ddot{e}(t)$	eye acceleration (EA)
$\ddot{p}(t)$	target acceleration

$p(t)=k$	stationary target
$p(t)=e(t)$	ideal stabilization
$p(t)=e(t-\varepsilon)$	lab stabilization
$p(t)=e(t)+d(t)$	open-loop
$p(t)=e(t)-e(t-\delta_2)$	transient stabilization

$p(t)-e(t)$	retinal position error (RPE)
$\dot{p}(t)-\dot{e}(t)$	retinal velocity error (RVE)
$\ddot{p}(t)-\ddot{e}(t)$	retinal acceleration error (RAE)

$\ddot{e}(t)=k_1\left[p(t-\delta_1)-e(t-\delta_1)\right]$ RPE drives EA

$\ddot{e}(t)=k_2\left[\dot{p}(t-\delta_1)-\dot{e}(t-\delta_1)\right]$ RVE drives EA

$\ddot{e}(t)=k_3\left[\ddot{p}(t-\delta_1)-\ddot{e}(t-\delta_1)\right]$ RAE drives EA

$\dot{e}(t)=k_2\left[p(t-\delta_1)-e(t-\delta_1)\right]$ RPE drives EV

$\ddot{e}(t)=k_2\left[\dot{p}(t-\delta_1)-\dot{e}(t-\delta_1)\right]$ RVE drives EA

Predictions

$p(t)=e(t)-e(t-\delta_2)$ transient stabilization

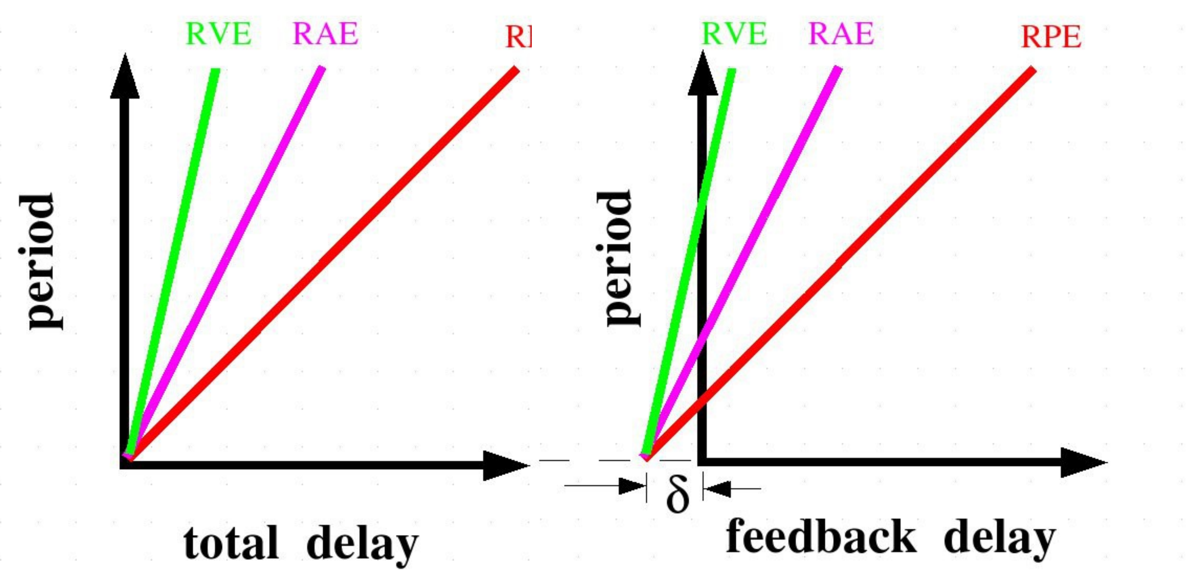
$\ddot{e}(t)=k_1\left[p(t-\delta_1)-e(t-\delta_1)\right]$ RPE drives EA

$$\ddot{e}(t)=k_1\left[e(t-\delta_1)-e(t-\delta_1-\delta_2)-e(t-\delta_1)\right]$$

$$\ddot{e}(t)=-k_1 e(t-\delta_1-\delta_2)$$

$$\ddot{e}(t)=-k_1 e(t-\delta)$$

$\lambda=\delta$	RPE drives EA
$\lambda=4\delta$	RVE drives EA
$\lambda=2\delta$	RAE drives EA
$\lambda=\dfrac{4\delta}{4n+2-N_d}$	
$\lambda=\dfrac{4}{3}\delta$	RPE drives eye jerk



Results

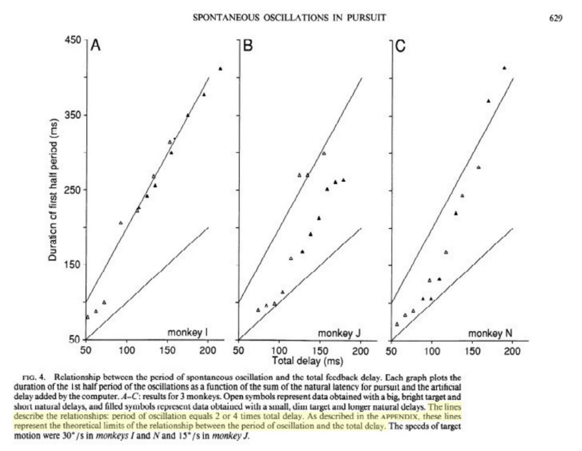
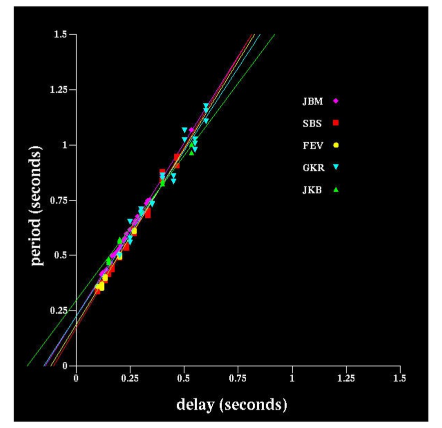


Figure from Goldreich, Krauzlis & Lisberger (1992).



BIG QUESTION:

Can we demonstrate a position-driven pursuit response for certain classes of stimuli?

Approach:

Delayed Visual Feedback
(see Background panel at left)

Motivation:

Previous work suggests pursuit responses combine signals from volunatry and reflexive pathways with different properties, which respond to different stimuli.

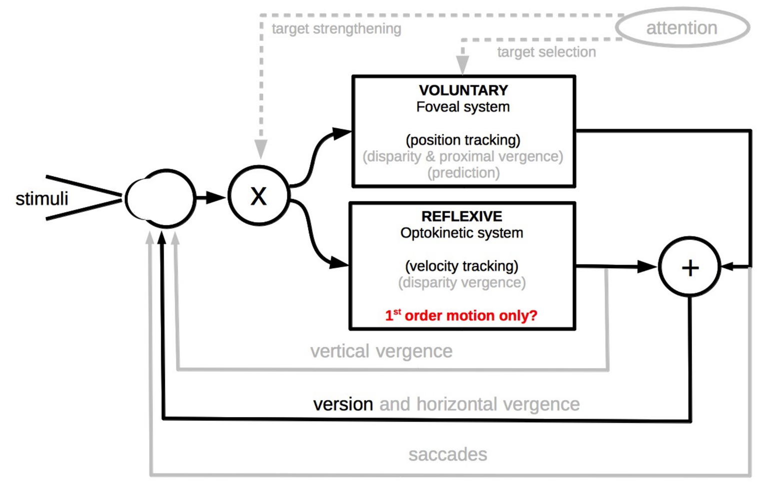
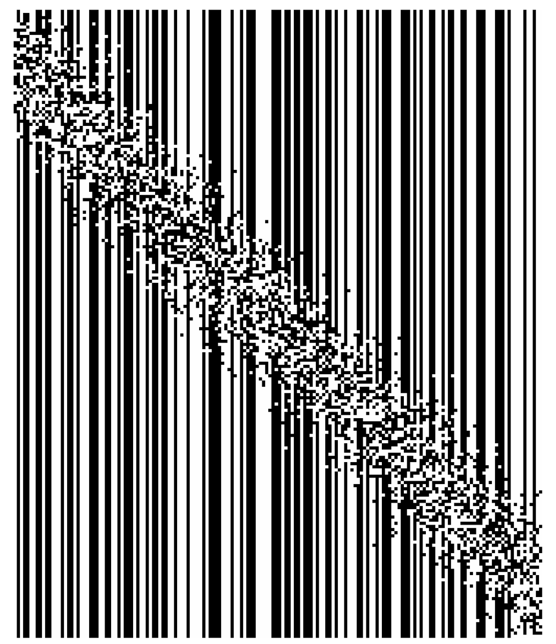


Figure from Mulligan, Stevenson & Cormack (2013), showing proposed architectural model of pursuit control system, with portions relevent to this poster highlighted.

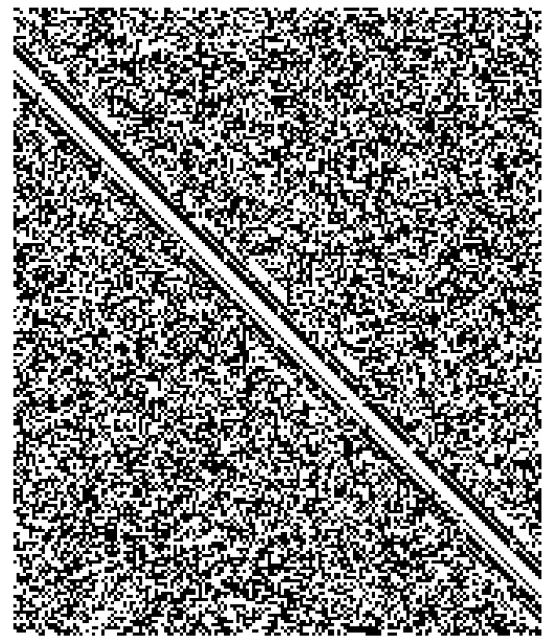
Stimuli

Space-time plots showing time (top-to-bottom), and one spatial dimension for the four classes of stimuli studied.

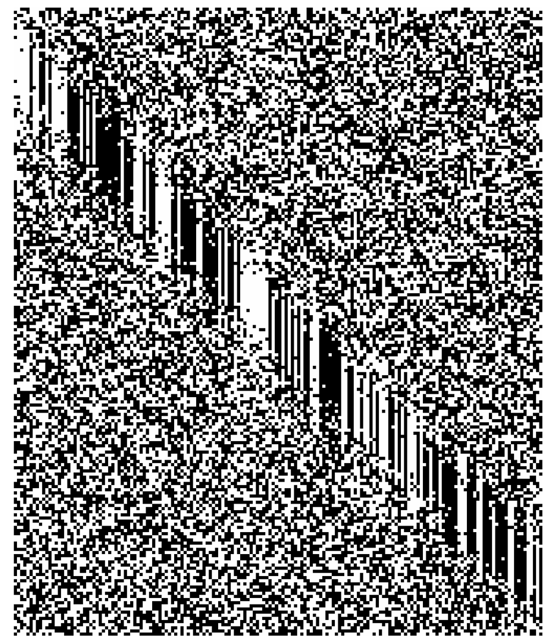
"black"



"twinkle"



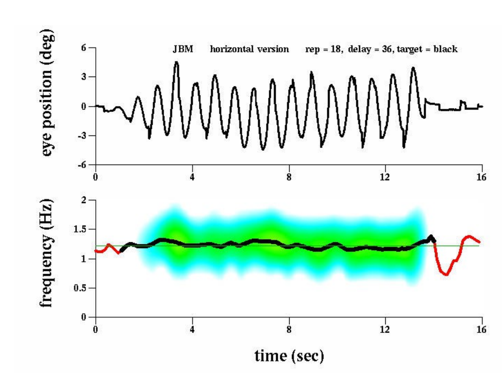
"rigid"



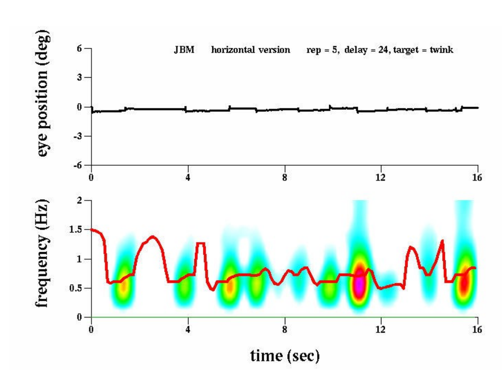
"static"

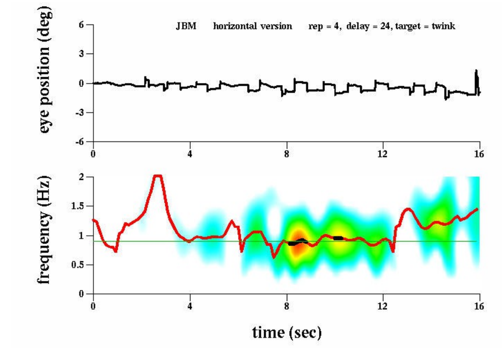
Trials

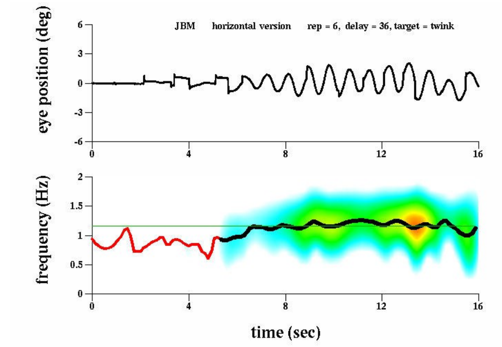
Vigorous oscillation seen with conventional target



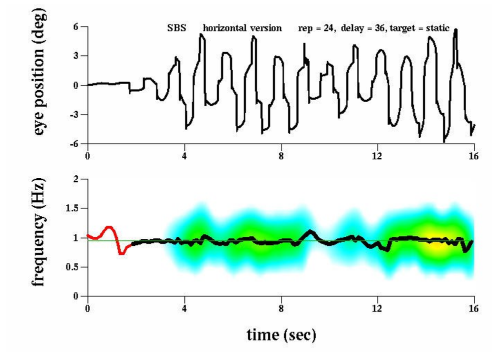
Twinkle target oscillates only after learning



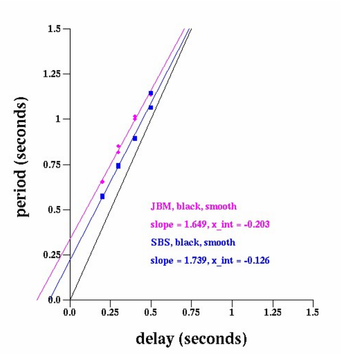


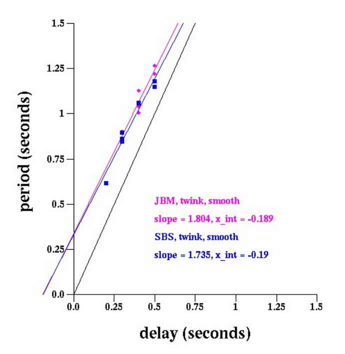


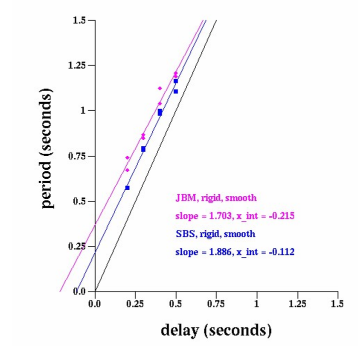
"Static" target show mixed response

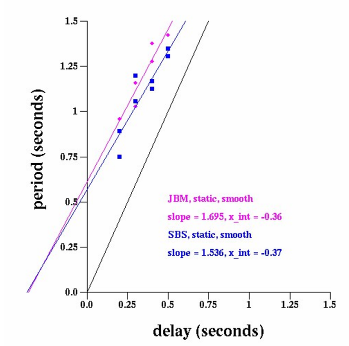


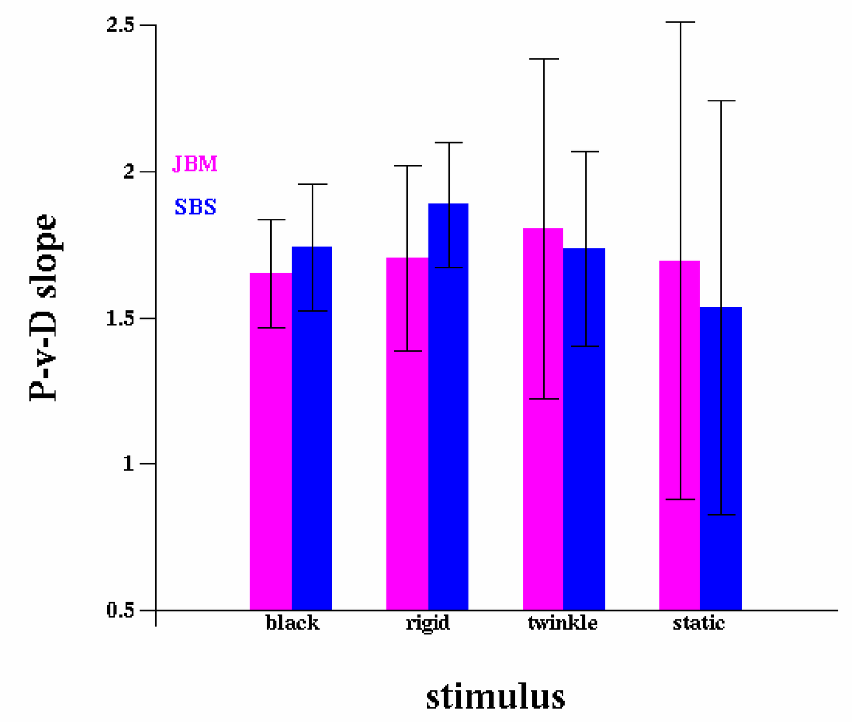
Results











Conclusion

Can we demonstrate a position-Driven pursuit response for certain Classes of stimuli?

TODAY'S ANSWER: Not yet...

References

Goldreich, D., Krauzlis, R. J., and Lisberger, S. G. (1992). "Effect of changing feedback delay on spontaneous oscillations in smooth pursuit eye movements in monkeys." J. Neurophysiol., 67(3), 625-638.

Mulligan, J. B., Stevenson, S. B., and Cormack, L. K. (2013). "Reflexive and voluntary control of smooth eye movements." in Rogowitz, B.E. Pappas, T.N., and de Ridder, H. (eds.), *Human Vision and Electronic Imaging XVIII*, Proc SPIE, v. 8651.